

(19) World Intellectual Property Organization  
International Bureau



(43) International Publication Date  
1 February 2001 (01.02.2001)

PCT

(10) International Publication Number  
**WO 01/06934 A1**

(51) International Patent Classification<sup>7</sup>: **A61B 17/02**

(21) International Application Number: **PCT/AU00/00887**

(22) International Filing Date: **25 July 2000 (25.07.2000)**

(25) Filing Language: **English**

(26) Publication Language: **English**

(30) Priority Data:  
PQ 1828 **27 July 1999 (27.07.1999) AU**

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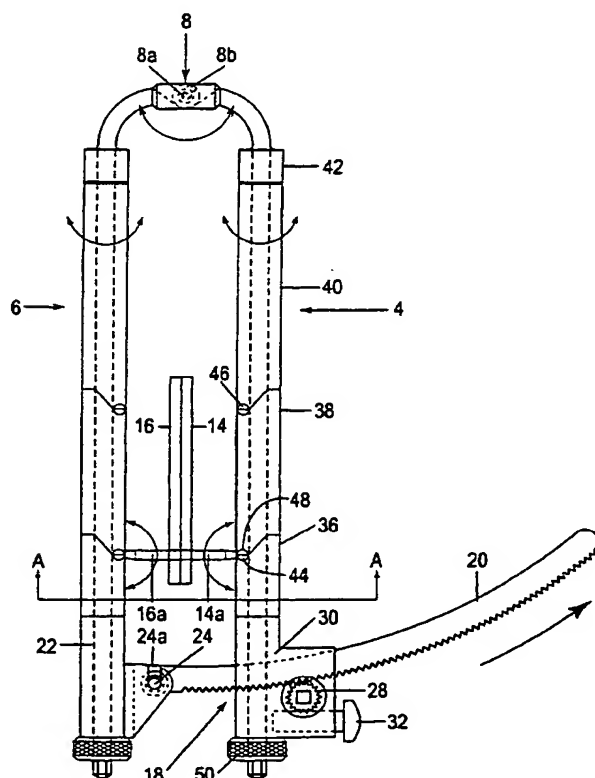
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(81) Designated States (national): AE, AG, AL, AM, AT, AU, AZ, BA, BB, BG, BR, BY, BZ, CA, CH, CN, CR, CU, CZ, DE, DK, DM, DZ, EE, ES, FI, GB, GD, GE, GH, GM, HR, HU, ID, IL, IN, IS, JP, KE, KG, KP, KR, KZ, LC, LK, LR, LS, LT, LU, LV, MA, MD, MG, MK, MN, MW, MX, MZ, NO, NZ, PL, PT, RO, RU, SD, SE, SG, SI, SK, SL, TJ, TM, TR, TT, TZ, UA, UG, US, UZ, VN, YU, ZA, ZW.

(84) Designated States (regional): ARIPO patent (GH, GM, KE, LS, MW, MZ, SD, SL, SZ, TZ, UG, ZW), Eurasian patent (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European

[Continued on next page]

(54) Title: **SURGICAL RETRACTOR**



(57) Abstract: A retractor for use in surgery, such as chest surgery, comprises two arms (4, 6) each adapted to carry a blade (14, 16) engageable with one side of an incision, the two arms (4, 6) being connected by a pivot (8) at one end portion such that the arms (4, 6) can be pivoted between a closed position and an adjustable open position in which the arms define a substantially V-shaped configuration in which the blades (14, 16) maintain the sides of the incision in inclined relation. The arms are moved to the open position by means of a curved rack (20) carried by one of the arms (6) and a pinion (28) carried by the other arm (4), the pinion (28) being releasably lockable to retain the arms in the open position by a ratchet and pawl mechanism.



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patent (AT, BE, CH, CY, DE, DK, ES, FI, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE), OAPI patent (BF, BJ, CF, CG, CI, CM, GA, GN, GW, ML, MR, NE, SN, TD, TG).

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**Published:**

— *With international search report.*

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### Surgical Retractor

This invention relates to retractors for use in surgery, and more particularly, but not exclusively, to retractors for use in chest surgery.

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When a patient is incised for surgery, the sides of the incision are parted and are held apart by a retractor so that the surgeon has the required access to the patient's body. Conventionally, previously proposed retractors for chest surgery comprise two parallel arms, with blades disposed thereon to engage the sternum (breastbone). The operation of  
10 these retractors is such that the retractor arms remain parallel throughout their range of motion, resulting in the sides of the incision being parted by the same amount along the length of the retractor.

With particular regard to cardiac (heart) surgery, the ribs attached to the lower  
15 (inferior) portion of the sternum are longer and are provided with more cartilage and greater elasticity than the ribs attached to the upper portion of the sternum. This results in the upper (superior) ribs having less tolerance for displacement. The use of parallel-opening retractors for spreading the sternum for cardiac operations exerts greater force on the upper ribs, which may fracture. Another disadvantage of these retractors is that their  
20 use in spreading the sternum may result in excessive traction on the nerves (brachial plexus) leading to the patient's arm. Damage to these nerves can cause weakness or long term loss of feeling in the patient's ring and little fingers. One way to avoid applying excessive stress to the upper ribs is to position the retractor as low as possible. However, this approach does not allow the retractor to be placed in the most advantageous position  
25 for chest surgery and can cause damage to the sternum by having mainly the edges, rather than the full surfaces, of the blades exerting pressure on the sides of the incision.

During surgery, it is often necessary to open the incision both horizontally and vertically. Typically, two separate retractors have been required for this, one for the  
30 horizontal opening and another for the vertical opening. The applicant has determined that it would be beneficial to have a single retractor which could part the sternum with minimal

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displacement at the upper end and maximal displacement at the lower end, a "V"-shaped displacement, in both the horizontal and vertical planes. -

5 In accordance with the present invention, there is provided a retractor for use in surgery comprising two arms each adapted to carry a blade engageable with one side of an incision, the two arms being connected by a pivot at one end portion such that the arms can be pivoted between a closed position and an adjustable open position in which the arms to define a substantially V-shaped configuration in which the blades maintain the sides of the incision in inclined relation, and means for retaining the arms in the open position.

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Preferably, each of the arms carries at least one sleeve rotatably mounted around the arm, the blade being mounted by the sleeve and the sleeve being lockable in a selected angular orientation whereby to change the angular orientation of the blade. This allows a V-shaped displacement of the retractor in both the horizontal and vertical planes.

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Preferably, the blade is movable into a selected position along the arm. In one particularly preferred form there is an assembly of such sleeves on the arm lockable in end to end relation in a variable angular orientation and the blade is retained by co-operation between different pairs of adjacent sleeves to permit adjustment in blade position. The sleeves may also be interchangeably positioned on the arm to permit further adjustment of blade position.

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Preferably, the blades are mounted by balls engaging within sockets formed by adjacent end faces of adjacent sleeves.

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Preferably, the blades are replaceable and are available in a range of sizes.

Further according to the invention, there is provided a retractor for use in surgery comprising two arms each adapted to carry means engageable with the zone of an incision, the two arms being connected by a pivot at one end portion such that the arms can be pivoted between a closed position and an adjustable open position in which the arms define

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a substantially V-shaped configuration, and means for retaining the arms in the open position.

In one form the means engageable with the zone of an incision comprise means  
5 adapted to grip on the surface of an organ such as the heart.

The preferred embodiment of the invention will now be described, by way of example only, with reference to the accompanying drawings in which:-

10 Figure 1 is a top view of a preferred embodiment of a retractor in a closed position;  
Figure 2 is a right side view of the retractor illustrated in Figure 1;

Figure 3 is a front view of the retractor illustrated in Figure 1;

15 Figure 4 is a section through A-A of Figure 1; and

Figure 5 is a section through A-A of Figure 1 and showing how the retractor can be opened and inclined to hold one side of an incision higher than the other side.

20 The retractor in accordance with the preferred embodiment of the invention is principally for use in chest surgery and comprises two arms 4, 6 which are connected by a pivot 8 at their upper ends such that the arms 4, 6 can be pivoted between a closed position in which the arms are substantially parallel and an open position in which the arms 4, 6 are inclined to define a substantially V-shaped configuration. The arms 4, 6 each carry at  
25 least one blade 14, 16 for contact with tissue of the patient on either side of an incision such that opening of the arms 4, 6 opens the incision in a V-shape, the blades 14, 16 extending from the arms 4, 6 via support arms 14a, 16a rigidly connected to the blades. Preferably, the blades 14, 16 are replaceable and are available in a range of sizes to provide for various sizes and/or obesities of patients. The two arms 4, 6 are provided with locking  
30 means 18 to releasably hold the arms 4, 6 in a variable open position.

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In the preferred embodiment, the locking means 18 includes an arm in the form of a curved rack 20, the curve being a circular arc centred substantially at the pivot 8. One end of the rack 20 is fixed to an end sleeve 22 of the arm 6 by a pivot 24. A toothed outer edge 26 of the rack 20 engages a driving pinion 28, rotatably mounted on an end sleeve 30 of the other arm 4, throughout a range of openings provided by the length of the rack 20. The pinion 28 is associated with a ratchet and pawl mechanism having a first "ratchet" state in which rotation of the pinion 28 in only one direction is allowed such that only opening movement of the arms 4, 6 is possible. A second "free" state allows both opening and closing movement of the arms 4, 6. The state of the mechanism can be changed by switching of a pawl release 32. The pinion 28 is drivable by means of a crank handle 34 in order to open the arms 4, 6 and hence to open the incision. The crank handle 34 is detachable from the pinion 28 to reduce interference during surgery.

The sleeve 30 is removably mounted on the arm 4. The arm 4 also carries further sleeves 36, 38, 40 between the sleeve 30 and a sleeve-like abutment 42 at the upper end portion of the arm 4. The sleeve 30 and adjacent sleeve 36 are engageable via serrations or other formations on their adjacent end faces in order to lock the sleeves 30, 36 against relative rotation. The adjacent end faces of the sleeve 40 and the abutment 42 also have similar serrations or other formations engageable to lock that sleeve 40 against rotation relative to the abutment 42. The end faces of the intermediate sleeve 38 and the adjacent faces of the sleeves 36 and 40 are shaped to cause rotational interlocking of the three sleeves 36, 38, 40. These adjacent interlocking faces of the three sleeves 36, 38, 40 are also configured to define sockets 44, 46 for receiving selectively a mounting ball 48 at the end of the support arm 14a carrying the blade 14. The assembly of the four sleeves 30, 36, 38, 40 on the arm 4 can be firmly secured to the arm 4 by means of a knurled nut 50 threadedly mounted at the lower end portion of the arm 4. When tightened the nut 50 will cause the uppermost sleeve 40 to be locked against the abutment 42 and due to the interengaging end surfaces of the other sleeves 30, 36, 38, the assembly of four sleeves 30, 36, 38, 40 will be firmly locked to the arm 4 against relative rotation. The ball 48 at the end of the support arm 14a carrying the blade 14 will also be firmly locked in the socket 44 or 46 between the sleeves 36, 38 by tightening the nut 50. By slackening the nut 50, the

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ball 48 can be removed from one of the sockets 44 or 46 between the sleeves 36 and 38 and relocated in the other socket 44 or 46 between the sleeves 38 and 40 in order to adjust the position of the blade 14 lengthwise of the arm 4 to suit a particular patient. Prior to final tightening of the nut 50, the ball 48 is able to be swivelled within the socket 44, 46 to  
5 facilitate adjustment in the orientation of the blade.

It is to be noted that the sleeves 36 and 40 are of different lengths and are capable of being interchangeably positioned on the arm 4 to provide the possibility of further options for the lengthwise positioning of the blade 14 on the arm 4.

10

A corresponding set of sleeves 22, 52, 54, 56 which act in the manner just described is mounted on the other arm 6. These sleeves also have the same range of adjustment in position to facilitate adjustment in the position of the blade 16 along the arm 6 and adjustment of its orientation by swivelling of its mounting ball within the socket  
15 defined by the interlocking faces of the adjacent sleeves.

All of the sleeves 22, 30, 36-40, 52-56 are removable from the two arms 4, 6 for cleaning purposes and the sleeves 22 and 30 are interchangeably mounted on the arms 4 and 6 in order to change the direction of projection of the rack 20. The handle 34 may  
20 engage the pinion 28 from either side allowing the sleeve 30 to be used on either arm 4, 6.

When the nuts 50 are loosened, the angular positions of the sleeves 36-40, 52-56 on the arms 4, 6 can also be adjusted in order to change the angular orientation of the blades 14, 16 about the axis of the arms and the blades 14, 16 can be locked in their selected  
25 orientation by tightening the nuts 50 after adjustment of the angular position of the sleeves. This change in angular orientation may be necessary to suit the type of opening required by the surgeon. For example during chest surgery, the surgeon may require the incision to be opened not only horizontally but also one side of the incision to be lifted vertically relative to the other side to facilitate access (see Figure 5). Thus the deep aspect of the chest wall  
30 on one side may be exposed, allowing access to the internal mammary (thoracic) artery for harvest. The adjustment in the angular position of the blades 14, 16 facilitates this.

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Blades 14, 16 of differing design can be interchangeably mounted on the arms 4, 6 in order to adapt the retractor for different uses. Figure 4, for example, illustrates blades with simple cranked legs and Figure 5, for example, illustrates blades with legs of a more  
5 complex shape.

The retractor of the preferred embodiment in opening into a V-shaped configuration has the advantage of reducing the displacement of the upper portion of the chest during sternal surgery so that there is less risk of damage to the patient, in particular  
10 to the upper ribs and to the brachial plexus. The single retractor can be used to open the incision both vertically and horizontally, with the free end of the curved rack 20 extending in either direction, due to the interchangeability of the various components on the arms. The position of the blades 14, 16 can be altered to accommodate different sizes of chest and/or incision. Another advantage is the minimisation of extremities likely to cause  
15 interference during surgery. The retractor provides a rigidly held opening which offers improved access and vision to the surgeon.

The retractor can be completely disassembled for cleaning. As previously discussed, all of the sleeves are removable from the arms. The rack 20 is detachable from  
20 the sleeve 22 by sliding the pivot 24 of the rack 20 out of a slot-like pivot mounting 24a of the sleeve 22. The pivot 8 by which the two arms 4, 6 are pivotally connected consists of a pivot pin 8a on one of the arms releasably engageable in a slot-like pivot mounting 8b on the other of the arms, whereby the two arms can be disconnected by sliding the pin 8a out of the mounting 8b.

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The pivot 24, in addition to allowing detachment of the rack 20, also provides limited freedom for movement of the rack 20 during use to permit ease of tension from the rack 20 and thereby ease of operation of the pawl release 32.



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Optionally, clamps may be provided for application externally to the sleeves for specific applications such as valve retractor blades, beating heart stabilising devices, pericardial retractors, or holders for mister/blower devices.

- 5           The retractor described is not useable only for heart surgery but also is of benefit in other forms of surgery, for example abdominal surgery. A retractor in accordance with the invention designed specifically for abdominal surgery may have arcuately curved arms rather than straight arms as illustrated.
- 10           Although in the embodiment illustrated the arms mount the removable sleeves by which the blades are clamped, in alternative constructions provision for the removable sleeves may be omitted, with the arms being of a diameter such that blades can be clamped directly to the external surfaces of the arms. This construction will suffice in situations where the torque applied to the blades during use does not necessitate the mounting
- 15           arrangement particularly described herein. In this form of the retractor, it is not necessary for the arms to be of circular cross-section and arms of other suitable form for the attachment of blades and other components can be provided, for example arms of rectangular cross-section or arms of flattened strip-like form.
- 20           A substantially smaller version of the retractor just described may be of benefit in other forms of surgery, such as "beating heart" surgery. In this version the arms do not carry retractor blades, but instead are of a generally flattened shape with small spikes, suction pads, and tape holders to grip on the surface of the heart and thereby to stabilise the segment of the surface of the heart defined between the two arms in their V-shaped open
- 25           state. This form of retractor still includes the ratchet-type locking means 18 with the curved rack.

The embodiment has been described by way of example only and modifications are possible within the scope of the invention.

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Throughout this specification and claims which follow, unless the context requires otherwise, the word "comprise", and variations such as "comprises" or "comprising", will be understood to imply the inclusion of a stated integer or group of integers or steps but not the exclusion of any other integer or group of integers.

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## CLAIMS:-

1. A retractor for use in surgery comprising two arms each adapted to carry a blade engageable with one side of an incision, the two arms being connected by a pivot at one end portion such that the arms can be pivoted between a closed position and an adjustable open position in which the arms define a substantially V-shaped configuration in which the blades maintain the sides of the incision in inclined relation, and means for retaining the arms in the open position.
2. A retractor according to claim 1, wherein the means for retaining the arms in the open position comprises a curved bar carried by one of the arms at an end portion thereof remote from the pivot, with the centre of curvature of the bar coinciding with the pivot, said curved bar co-operating with means carried by the other arm for releasably locking the bar relative to said other arm in a selected position to maintain the required V-shaped configuration of the arms.
3. A retractor according to claim 2, wherein the curved bar is in the form of a toothed rack engageable with a driving pinion carried by the other arm, said driving pinion being rotatable to cause opening movement of the arms.
4. A retractor according to claim 3, comprising a removable handle engageable with the driving pinion for actuating the pinion.
5. A retractor according to any one of claims 2 to 4, wherein the locking means comprises a ratchet and pawl mechanism operative to permit movement of the arms in an opening direction and to releasably lock the arms against movement in the closing direction.
6. A retractor according to claim 5 when dependent on claim 3, wherein the ratchet

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and pawl mechanism acts on the driving pinion to thereby releasably lock the pinion and thereby the rack in a position to prevent closing movement of the arms.

7. A retractor according to any one of claims 1 to 6, further comprising retractor  
5 blades, and means for mounting the blades to the arms in selected positions along the length of the arms and at selected angular orientations about the axis of the arms.

8. A retractor according to claim 7, wherein the means for mounting the blades  
10 comprises at least one sleeve rotatably mounted on each arm, the blades being mounted by the respective sleeves and the sleeves being lockable in selected angular orientations about the arms.

9. A retractor according to claim 8, comprising an assembly of said sleeves mounted  
15 on each arm and lockable in end-to-end relation in a variable angular orientation, the blade being clamped to the arm by co-operation between adjacent end faces of pairs of adjacent sleeves.

10. A retractor according to claim 9, wherein there are several such sleeves mounted on  
20 each arm and variation in blade position along the length of the arm is effected by clamping the blade between different pairs of said sleeves.

11. A retractor according to claim 10, wherein at least some of said sleeves are of  
25 different lengths and are interchangeably mountable on the arm in different positions to enable additional adjustment in blade position along the arm.

12. A retractor according to any one of claims 9 to 11, wherein adjacent end faces of  
30 adjacent sleeves define a socket for receiving a mounting ball at the proximate end portion of an arm of the blade whereby to permit the arm to be swivelled within the socket and to be clamped in a selected angular position.

13. A retractor according to any one of claims 9 to 12, wherein each arm includes a

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screw device actuable to clamp the assembly of sleeves in end-to-end relation in a selected angular orientation about the arm.

14. A retractor according to any one of claims 9 to 13 when dependent on claim 6,  
5 wherein the rack is carried by a further said sleeve removably mounted on the said one arm and the driving pinion and ratchet and pawl mechanism is carried by a further said sleeve removably mounted on the other of said arms, each of said further sleeves lying in end-to-end relation with the said assembly of sleeves on the associated arm.
- 10 15. A retractor according to any one of claims 1 to 14, wherein the pivot is demountable to permit detachment of the two arms for cleaning purposes.
16. A retractor according to any one of claims 1 to 15, wherein the arms are substantially straight and are substantially parallel in a closed condition of the retractor.
- 15 17. A retractor according to any one of claims 1 to 15, wherein the arms are arcuately curved.
18. A retractor according to any one of claims 1 to 17, further comprising retractor  
20 blades adapted to be clamped to the external surfaces of the retractor.
19. A retractor according to any one of claims 1 to 6, further comprising retractor blades adapted to be clamped to the external surfaces of the arms.
- 25 20. A retractor according to claim 8 or any claim dependent on claim 8, further comprising retractor blades adapted to be clamped to the external surfaces of the sleeves.
21. A retractor for use in surgery comprising two arms each adapted to carry means  
engageable with the zone of an incision, the two arms being connected by a pivot at one  
30 end portion such that the arms can be pivoted between a closed position and an adjustable

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open position in which the arms define a substantially V-shaped configuration, and means for retaining the arms in the open position.

22. A retractor according to claim 21, wherein the means engageable with the zone of  
5 an incision comprise retractor blades.

23. A retractor according to claim 21, wherein the means engageable with the zone of an incision comprise means adapted to grip on the surface of an organ such as the heart.

10 24. A retractor according to any one of claims 21 to 23, wherein the means for retaining the arms in the open position comprises a curved bar carried by one of the arms at an end portion thereof remote from the pivot, with the centre of curvature of the bar coinciding with the pivot, said curved bar co-operating with means carried by the other arm for releasably locking the bar relative to said other arm in a selected position to  
15 maintain the required V-shaped configuration of the arms.

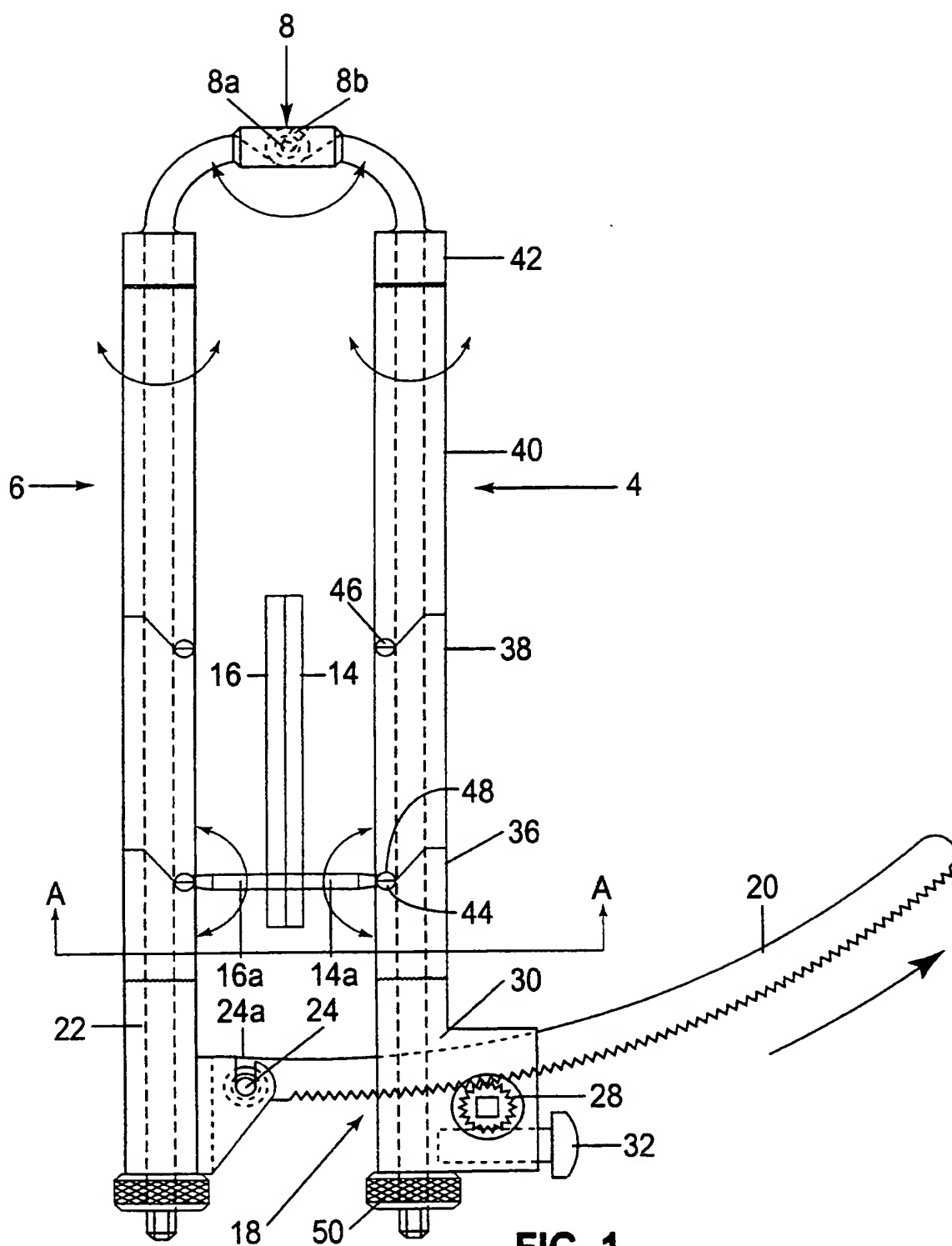
25. A retractor according to claim 24, wherein the curved bar is in the form of a toothed rack engageable with a driving pinion carried by the other arm, said driving pinion being rotatable to cause opening movement of the arms.

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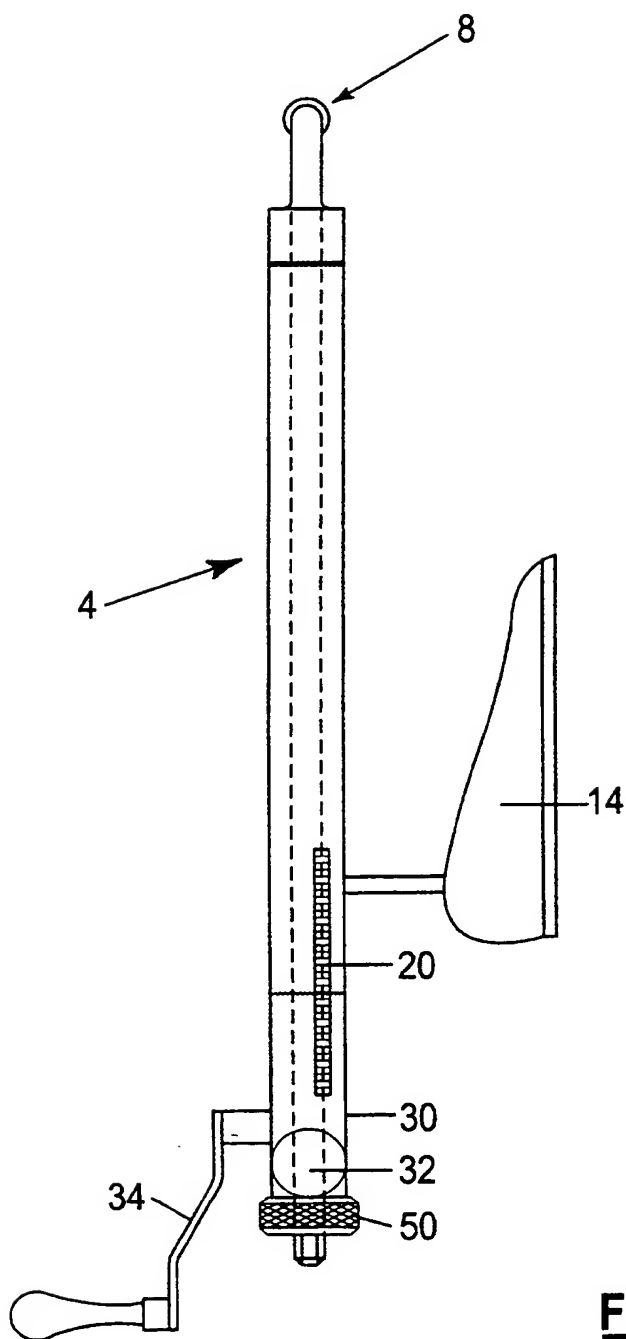
26. A retractor according to claim 24 or 25, wherein the locking means comprises a ratchet and pawl mechanism operative to permit movement of the arms in an opening direction and to releasably lock the arms against movement in the closing direction.

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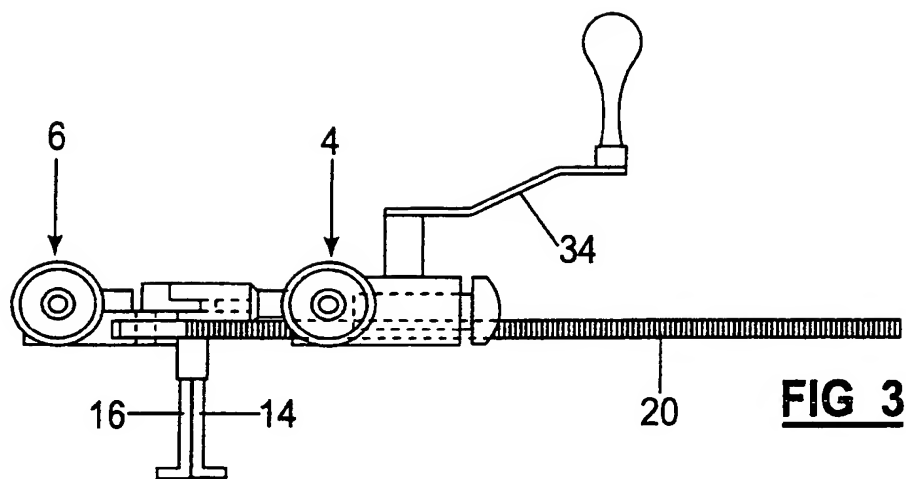
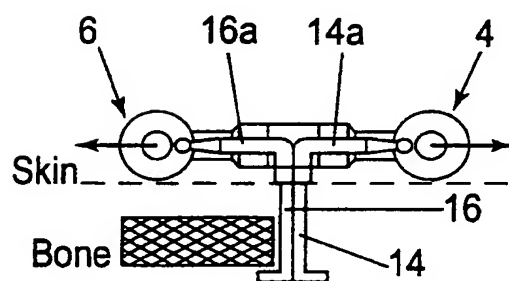
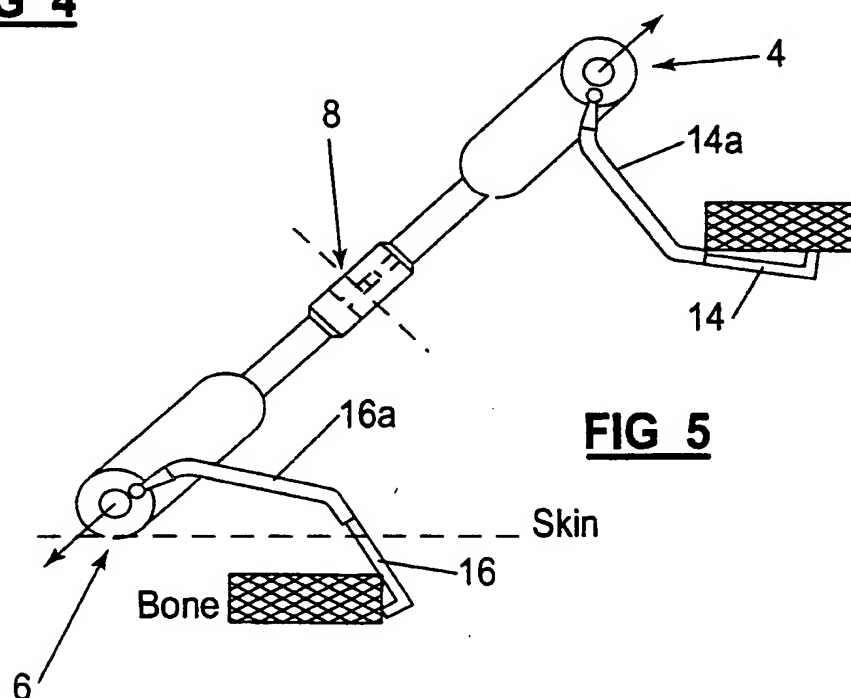
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**FIG 2**



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**FIG 3****FIG 4****FIG 5**

## INTERNATIONAL SEARCH REPORT

International application No.  
PCT/AU00/00887

<b>A. CLASSIFICATION OF SUBJECT MATTER</b>		
Int. Cl. <sup>7</sup> : A61B 17/02		
According to International Patent Classification (IPC) or to both national classification and IPC		
<b>B. FIELDS SEARCHED</b>		
Minimum documentation searched (classification system followed by classification symbols)		
Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched		
Electronic data base consulted during the international search (name of data base and, where practicable, search terms used) Derwent, Japio: chest, cardiac, pivot, hinge etc		
<b>C. DOCUMENTS CONSIDERED TO BE RELEVANT</b>		
Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	GB 2218912 A (Lazim) 29 November 1989 Whole document	1, 17 - 19, 21 - 23
X	WO 97/37596 A (Endoscopic Technologies Inc) 16 October 1997 Figures	1, 16 - 17, 19 - 22
X	DE 4415074 A (Aesculap AG) 17 August 1985 Whole document	1, 17, 19, 21 - 23
<input checked="" type="checkbox"/> Further documents are listed in the continuation of Box C <input checked="" type="checkbox"/> See patent family annex		
* Special categories of cited documents: "A" document defining the general state of the art which is not considered to be of particular relevance "E" earlier application or patent but published on or after the international filing date "L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified) "O" document referring to an oral disclosure, use, exhibition or other means "P" document published prior to the international filing date but later than the priority date claimed "T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention "X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone "Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art "&" document member of the same patent family		
Date of the actual completion of the international search 8 August 2000		Date of mailing of the international search report 16 AUG 2000
Name and mailing address of the ISA/AU AUSTRALIAN PATENT OFFICE PO BOX 200, WODEN ACT 2606, AUSTRALIA E-mail address: pct@ipaustralia.gov.au Facsimile No. (02) 6285 3929		Authorized officer  SUE THOMAS Telephone No : (02) 6283 2454

## INTERNATIONAL SEARCH REPORT

International application No.

PCT/AU00/00887

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT		
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X	US 5931777 A (Sava) 3 August 1999 Columns 3-6 and figures	1,16,18-19, 21-22
X	US 5297538 A (Daniel) 29 March 1994 Columns 2-4 and figures	1,7, 21-23
A	US 4627421 A (Symbas) 9 December 1986 Whole document	
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**INTERNATIONAL SEARCH REPORT**  
Information on patent family members

International application No.  
**PCT/AU00/00887**

This Annex lists the known "A" publication level patent family members relating to the patent documents cited in the above-mentioned international search report. The Australian Patent Office is in no way liable for these particulars which are merely given for the purpose of information.

Patent Document Cited in Search Report			Patent Family Member			
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US	5297538	NONE				
DE	4415074	US	5618260			
WO	9737596	WO	9737597	WO	9737581	AU 24511/97
		AU	24625/97	AU	26652/97	AU 26660/97
		EP	892652	US	5868703	WO 9737716
GB	2218912	NONE				
						END OF ANNEX